Investigation of Electromyographic Activity during *Salat* and Stretching Exercise

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Abstract— ***Salat* is a formal prayer practice by all Muslims. When performing *salat*, it involves with several movements namely standing, *takbeer*, bowing, prostration and sitting. The study was to quantify and compares the muscle activity (surface electromyographic signal) during *Salat* and stretching exercise. Three main movements in *Salat* (*takbeer,* bowing and prostration) and similar stretching exercises to the *Salat* movements were investigated. Thirty one male and female volunteers were participated in this study. The activity of the four investigated muscles: biceps brachii, triceps brachii, pectoralis major and upper trapezius were recorded during *salat* and stretching movements. The recorded signals were then analyzed using root mean square analysis. The results indicate similar muscle contractions activities during *salat* and stretching exercise. Even though, the root mean square values during stretching exercise is higher, a t-test shows there is statistically no significant difference between these two movements**

Keywords-Salat; exercise; electromyography

I. INTRODUCTION

The psychological theories strongly emphasize that regular physical exercise is important that could bring short and long term benefits. There are many different exercises that could be done each exercise has different benefit to the body.

As time goes by, new exercises were introduced on top of the existing regular exercises. For example, yoga has become popular nowadays that could give both physiological and psychological benefits [1]. Another new popular exercise is pilates, was introduced in the early 20th century based on body conditioning routine that could help in building flexible and lean muscles [2].

Numbers of research have been reported on alternative exercises in comparison with standard exercises. For example, Sherman et. al conducted an investigation on using yoga as an alternative therapy for low back pain problem and gave positive results [3]. Comparison study on the benefits of yoga and exercise has been conducted that show yoga provides same benefits [4].

Salat (prayer) is performed by Muslim believers which must be performed at least five times a day. It involves with physical activities which includes standing, bowing prostration and sitting consecutively. It can be seen that from this consecutive movement, *salat* can also be considered as a slow moderate exercise. Benefits of *salat* from the spiritual point of view have been discussed at length by religious scholars. However, there is still little discussion on the *salat*'s benefit from science perspective even though it can be seen that performing *salat* is like performing slow and moderate exercise. Ibrahim et al have reported on the heart rate activities during *salat* performance which show positive effects to doers [5-8].

The objective of this work is to investigate the muscle activities of the upper human body during *salat* and stretching exercise. Three postures from *salat* movement were investigated, which were *takbeer,* bowing and prostration. For each investigated posture, there is its companion stretching exercise which will be also investigated for comparison. It is hypothesized that the two movements provide similar muscles activities that suggest apart from spiritual act, *Salat* can be an alternative exercise as well.

II. METHODOLOGY

A total of thirty one participants (age: 29 $\pm$ 8.8 (average $\pm$ SD)) with no medical history volunteered to participate in this study. Prior to the data collection, each participant was explained on the procedures and a consent form was signed.

The electromyographic (EMG) signals were acquired using disposable Ag/AgCl single electrodes (diameter 15 mm, centre spacing 20mm). The electrodes were placed on both left and right sides of the body of the four investigated muscles; triceps brachii (TB), biceps brachii (BB), pectoralis major (PM) and upper trapezius (UT) with a reference electrode at the elbow. The electrodes were connected to the 8 channel EMG data acquisition system (Myomonitor IV Wireless Transmission, Delsys) that works in conjunction with Delsys EMGWorks acquisition software. The EMG bandwidth was set at 10-500Hz and the sampling rate was 1500Hz.

This work is supported in part by Malaysia Prime Minister's Department through a Special Grant: Project number 66-02-03-0061/H-00000-37039

The participant was first instructed to do s*alat* movement. The movement began with the participant in standing position, followed by *takbeer*, standing, bowing, standing, prostration and end by sitting on the knee position. The data collection was repeated for three times. Figure 1 shows the three investigated postures and for the protocol, standardized time was set for each position and this is explained in the flowchart in figure 2.

Figure 1. From left to right: *Takbeer*, bowing and prostration

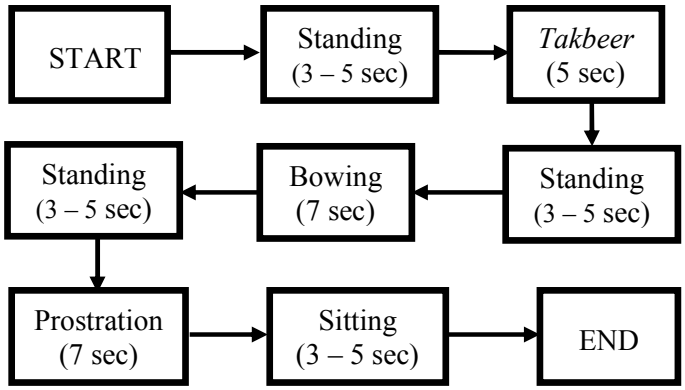

Figure 2. A flowchart for the *salat* movement

The participant then performed the stretching exercise. They followed the same protocol like in figure 1. The differences were only during *takbeer*, bowing and prostration motions where they performed its companion stretching exercise as shown in Table 1. Like *salat*, they also had to repeat the measurement for three times.

Table 1: *Salat* vs. stretching exercise

Salat	**Stretching Exercise**
Takbeer	Pectoralis stretch
Bowing	Good morning exercise
Prostration	Child's Pose

All the stretching postures follow the same postures in *salat* like shown in figure 1. The differences are as follows:

i. Pectoralis stretch – the participants stretch their upper limb until the feel their muscles are fully contract.
ii. Good morning exercise – a chair will be placed in front of the participants and during bowing, they will touch the chair by stretching out their upper limb.
iii. Child's pose – In the prostration posture, the participants will stretch out their upper limbs.

For data analysis, the recorded EMG signals during salat and stretching were identically processed. Using the EMGWorks 3.5 analysis software, the root mean squared (RMS) of the EMG signal were calculated during the muscle contractions. The values of all RMS were then averaged. A t-test (95% confidence interval) was used to look for the significant difference between *Salat* and stretching postures in terms of the EMG RMS values. Results was considered significant for $p<0.05$. For the statistical analysis, the SPSS 16.0 was used.

III. RESULTS AND DISCUSSION

All the recorded EMG signals indicate there were muscles contractions for all the investigated muscles during *salat* and exercise. For each movement, the EMG data was recorded for one complete cycle which took about 45 sec duration. Figure 3 shows the recorded EMG data from one participant during *salat.*

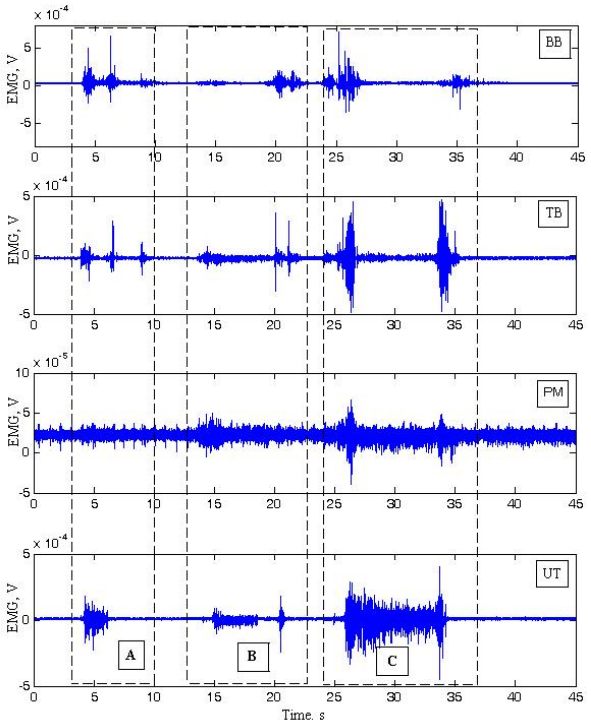

Figure 3. A recorded EMG signal from one participant performing *salat*. A: *takbeer*, B: bowing and C: prostration from the investigated muscles: BB – biceps brachii, TB – triceps brachii, PM – pectoralis major and UT – upper trapezius

The data analysis can be divided according to the postures which are *takbeer*, bowing and prostration. For each posture, the muscle activities from each investigated muscles will be examined. The results also differentiate the muscle activities

Figure 4 shows the average RMS of the EMG signals during *takbeer* and pectoralis stretching postures. From the plot, it can be seen that both postures produced similar EMG activities except for UT. UT shows higher EMG activities

during pectoralis stretching for both male and female participants. This is as expected because during stretching, the participants stretched their upper limb towards the back until they felt maximum contraction on their muscles.

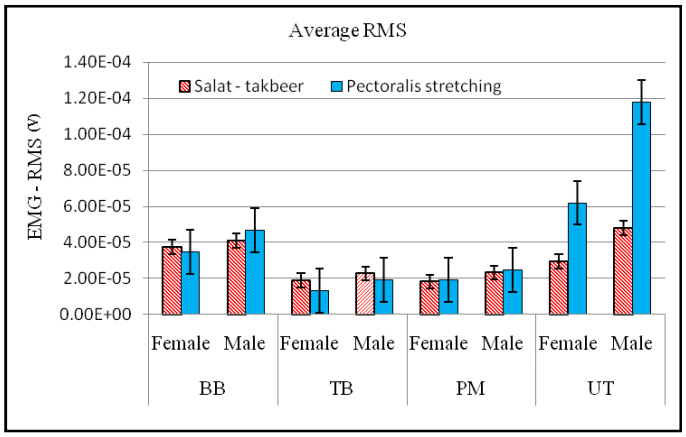

Figure 4. Average RMS during *takbeer* and pectoralis stretching postures between male and female participants

Figure 5 shows the average RMS during bowing and good morning exercise. In comparison on all the muscle activities, UT and TB shows higher activities compared to BB and PM. From the paired 't'-test, it shows that there is no significant difference between bowing and good morning exercise in BB and PM.

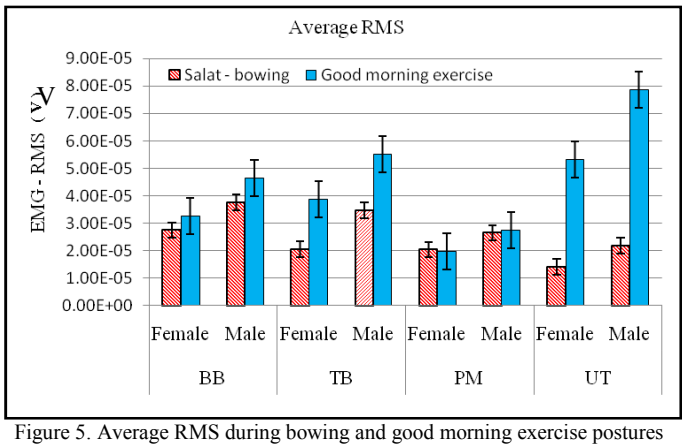

Figure 5. Average RMS during bowing and good morning exercise postures between male and female participants

The average RMS during prostration and child's pose exercise is shown in figure 6. Contrary with the results presented in figure 4 and figure 5, it shows that all the muscles shows similar EMG activities. Even though the main difference between these two postures is on the upper limb position, they still gave similar muscles activities

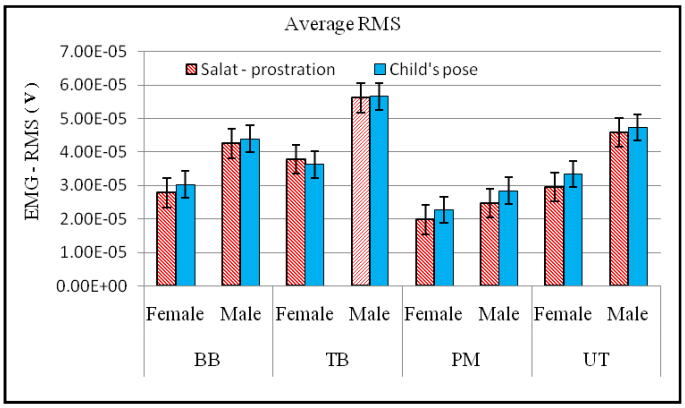

Figure 6. Average RMS during prostration and child's pose postures between male and female participants

IV. DISCUSSIONS

This work presents the outcome of the investigation on *salat* and stretching exercise movements. The main difference between these two postures is at the upper limb positions. The findings show similar muscle activities between postures in *salat* and stretching exercises in all the investigated muscles except for UT. Higher UT activities can be seen for both male and female participants during pectoralis and good morning stretching exercises. The results are expected since both movements involved with maximum contraction on the UT. However, for the prostration, it can be observed that all the muscles show similar EMG activities.

The findings indicate that *salat*, apart as a spiritual act, it can also act as a form of exercise that is done slowly and moderately. All Muslims must perform *Salat* at least five times a day and by performing them, it could help in the joints' flexibility and movements. This also suggests that, *salat* movements can be another alternative to the existing exercises, like yoga and pilates.

V. CONCLUSIONS

This study investigated the muscles activities between *salat* (Muslim's prayer) and stretching exercise. Three postures in *salat* have been investigated and compared to similar stretching exercise, which were *takbeer*, bowing and prostration. It is found that all investigated postures produced similar EMG activities, except for UT. This proves that *salat* has musculoskeletal effect like stretching. As part of spiritual act, the doers also perform slow and moderate exercise at the same time which could benefit their health.

ACKNOWLEDGMENT

This research is supported and funded by the Malaysia Prime Minister's Department through a Special Grant: Project number 66-02-03-0061/H-00000-37039

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